Freehand Gestural Selection Design for Interactive Television

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Abstract
Televisions are delivering more interactive experiences with internet connections, various applications and interactive content. However, traditional TV remote controls are not well suited to such interactive TV platforms. With the widespread use of freehand gestural interaction enabled by low-cost cameras, gestural interfaces are a promising solution for controlling interactive TV. Currently, freehand gestural interaction is still challenging and often does not lend itself to established interaction techniques that have been developed for traditional graphical user interfaces. In this paper we propose a design method for freehand gestural selection, which combines a Reach technique, expanding target and 3D freehand gesture, and we provide some brief examples of this design method.

Author Keywords
Freehand Gesture; Selection; Interactive TV

ACM Classification Keywords
H.5.2. [Information interfaces and Presentation]: User Interfaces – Input devices and strategies, Interaction styles.

General Terms
Design; Human Factors;

Introduction

The range and scope of interactive experiences on the TV platform is being driven by internet connectivity, applications and more interactive content. The TV platform brings more opportunities for an interactive living room experience. However, traditional TV remote controls are designed for dedicated functions such as changing channels and volume, and not well suited to more interactive scenarios. Although desktop input devices or touch surfaces could also be used to control the content on a TV display, they are usually intended to be installed adjacent or close to the display (e.g. keyboard, mouse and touch surface [2]), and are not suited to interactive TV in living rooms where users are normally some distance from the display.

Reasonably accurate 3D sensing techniques that can recognize freehand movements with a single camera are now beginning to be commercially available at low cost (e.g.Microsoft Kinect, Asus Xtion). This type of input device does not require on-body attachments or hands-on tracked devices, thus 3D freehand interaction can be used by ordinary users in daily life easily without the financial and usability costs of using tracked physical devices or markers. These features commend freehand gestures as a suitable interaction technique for living room TVs with very low configuration costs.

However, freehand mid-air gestural interaction is very different from traditional desktop interaction through hands-on devices. For example, there is no button or touch surface available with freehand interaction, and tracking by a single remote camera is typically low resolution and noisy. Furthermore, since the hand is moving in the air without any physical support, and making relatively large motor movements, the input data can be quite low in accuracy [7].

Such differences make interaction tasks that are easy in a desktop environment more challenging for freehand gestural interaction. For example, one of the fundamental interaction tasks, selection, can be performed easily and accurately by a mouse click or touch screen tap. However, it is more difficult for users to select a target by moving their hands freely in the air because of the lack of a button click/screen tap, and the low accuracy of input data with freehand interaction. In this paper, we propose a design method for freehand gestural selection combining the Reach technique, expanding target and the 3D nature of the freehand interaction, and give some design examples.

Combining Reach, Expanding Target and the Extra Dimension for Freehand Gestural Selection

Currently most commercial products (e.g. Xbox Kinect) use large icons and time thresholds for freehand gestural selection, requiring the cursor to stay within the target icon for a certain time to select. This method is designed for freehand selection without button clicks and screen taps, however, it normally requires large icons as users need not only to point to them, but also to stay inside the target for a while. Hence, it is not easy to select small targets with this method. The time threshold can also introduce issues such as selection delay and fatigue [5].

To avoid the problems of a time threshold selection method, a “Reach” technique, in which selection happens when the hand reaches the object boundary, may be a suitable technique for freehand interaction

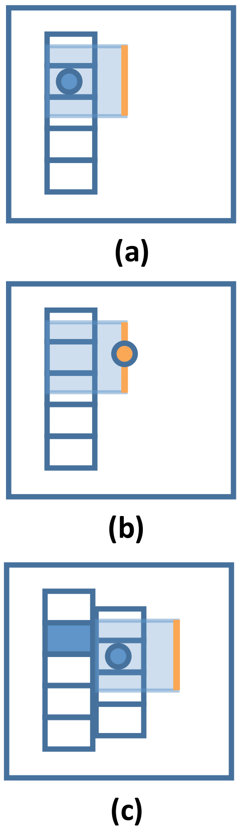

Figure 1. Selection for targets packed in 1D. The sphere is the cursor and follows the hand movement. Its color changes from blue to orange to indicate its reaching the target boundary. The orange line is the expanding target.

[6]. However, the noisy input from a single remote camera limits its ability with small targets, and goal crossing selection has also been found to perform better for large and close targets [1]. Thus, if the targets are small, it is still difficult to select the target effectively with a freehand Reach technique alone, and so the Reach technique could be improved further.

To make smaller target selection easier to perform, expanding the potential targets could be helpful. However, although expanding targets is a popular topic in 2D interface design [4], the experience with pointing devices or touch surfaces cannot simply be ported directly to freehand interaction because of the lack of button clicks or surface taps. Furthermore, expanding target selection in 2D interfaces with the point-and-click method has its own limitations. For example, expanding targets when the cursor approaches can magnify only in visual space but not motor space when the targets are closely packed [4]. Although a predictor could be used to increase the motor space before the cursor enters the target area, the benefit is very limited [4]. A 2D fisheye menu is also not as effective as a hierarchical menu, and may increase cognitive load [3].

To design more usable and effective freehand gestural selection, we should try to leverage the benefits of freehand movement (e.g. movement in 3D space), and try to avoid the disadvantages compared to traditional desktop 2D interaction (e.g. low tracking accuracy, no button click). The integration of the Reach technique, expandable targets and freehand 3D interaction could create powerful new tools for freehand gestural selection. For example, the user can move the hand to the target, and the target then expands in a certain direction to create a reachable boundary. The user then confirms the selection by reaching to the expanded boundary to complete the selection. In contrast to selecting with a mouse by pointing-and-clicking inside a 2D target, reaching the expanding boundary of a target can take place outside the original target position.

Design Examples

For the selection tasks, the targets could be single isolated objects, or more frequently, objects densely packed in 1D, 2D or even 3D space. Figure 1 shows an example of selection with expanding targets packed in one dimension. The menu items are in a vertical layout, and when the hand moves into one menu item, it expands (the light blue rectangle) and the user can reach for the right border (the orange line) of the expanded area to select this target (a). When the hand reaches the border, the item is selected (b). If it is a hierarchical menu, the next menu could be shown and use the same method to select (c). As pointed out by [3], greater selection height and stable position of menu items are important to the usability of a hierarchical menu, so this design is promising as it expands selection height without changing the menu layout.

This method can be used for selecting targets packed in one dimension, such as single or hierarchical menu selection. For a hierarchical menu, as the hand is located in the next menu after the selection (Figure 1(c)), so it increases the movement distance for only the last level. In addition to the rectangular menu layout and menu items, menu items and the expanding area could also be designed in other shapes.

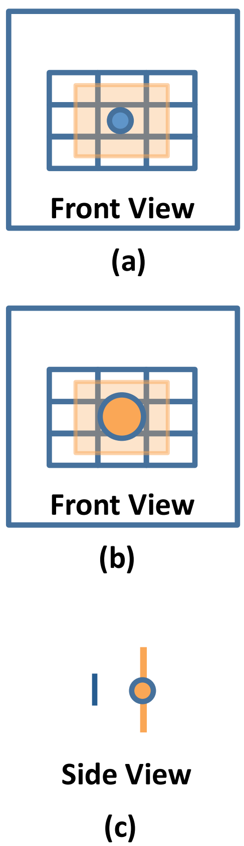

Figure 2. Selection for targets packed in 2D. The sphere is the cursor and follows the hand movement. Its color changes from blue to orange to indicate its reaching the target boundary. The orange rectangle is the expanding target.

Figure 2 illustrates selection for targets packed in 2D. There have been some efforts to address selection with occluded targets in 2D interfaces [8], while freehand 3D interaction introduces some novel opportunities. In this case, the expansion and reach selection cannot happen in the same 2D plane of the target, as shown in Figure 2, because all the targets are surrounded by others. However, the third dimension is available and can be used for expansion and selection. When the hand moves into a target, the target expands in another plane at a different depth along the Z dimension (a), e.g. 10 cm closer to the user's body from the current hand location. Then the user can move the hand in the third dimension to reach the expanded target area in order to select (b, c). A side view of the selection process is shown in (c). The blue line is the target and the orange line is the expanded target in another plane located at a different depth.

This method reveals the advantages of 3D movement with freehand gestural interaction. In 2D interfaces, it is very difficult to expand the targets packed together in motor space to facilitate selection. In contrast, the combination of 3D interface and 3D freehand movement creates a novel opportunity for expanding the target and selecting in 3D motor space. This method can be used widely for interacting with existing 2D content using freehand gestures, such as selecting links packed in 2D web pages or icons packed on a 2D desktop.

Conclusions

In this paper, we propose a freehand gestural design method for the fundamental interaction task of selection. The method combines a Reach technique, expanding target and the full 3D movement range of freehand gestures, and could be well suited to interaction with future TV platforms in living rooms. We have outlined some examples of this design method and our initial investigations have demonstrated some benefits of this design method. Ongoing work includes further development of detailed designs and user evaluations.

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